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MOBILE APP & IoT BASED SMART WEATHER STATION

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ABSTRACT

Nowadays weather conditions are changing day to day, hence some sort of system has to be designed to measure the weather parameters in an effective way at the place of interest. This paper projects an easy way to measure the dynamic parameters of weather without human interpretation. As this proposed method employs mobile app and IoT technology, collected weather parameters in a remote area can be uploaded to cloud as well as particular mobile app. The uploaded data can be verified and used, at anytime and anywhere in the world. The proposed system uses Raspberry-pi embedded with weather sensors to collect weather conditions. Hence, it provides better support for the weather monitoring and controlling centers, and weather reports for TV and radio stations.

KEYWORDS: Temperature & Humidity Sensor, Anemometer, Rain Gauge, Wind Vane, Light Intensity Internet of Things

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Original Article

INTRODUCTION

An automated weather station is an instrument that measures and records atmospheric parameters using sensors without intervention of humans. Monitoring the weather conditions helps in improving the productivity of crops and to ensure the safe working environment in industries, etc. Technological growth creates numerous easier ways to measure the environmental parameters compared to the past. Physical and environmental parameters are measured by using the sensors, which are miniaturized electronic devices. Monitoring the weather conditions by using the sensors provides results which are accurate and the entire system will be faster and most reliable. This paper describes the implementation flow of the weather monitoring station. This system includes the wireless communication technology IEEE 802.11 b/g (Wi-Fi in general terms). The system updates the information to the web page after monitoring the weather conditions periodically. By updating the data to the web page, we can maintain the weather conditions of a particular place that can be known readily verified anywhere in the world. The system consists of sensors and circuitry to find, wind velocity and wind direction, rainfall, temperature and Humidity, and light intensity. All this sensor can measure the corresponding weather parameters.

The system includes a raspberry-pi3 to process all the operations of the sensors and other peripherals. There are many local area network standards for communication, but they are all standalone communication processes and completely localized communications, but in our system the weather conditions should be monitored and updated all the time continuously, and we have to know the weather condition of a particular place, that can be informative at anywhere in the world. The effective parameters of the weather that can be stored in a cloud could be downloaded and this data can be further processed. The system is equipped with sensor devices that act as a client to send the data to the web server. For establishing a connection between the sensor network and internet, we used a Wi-Fi module as an

additional communication interface controlled by the raspberry-pi3. A Wi-Fi module requires a source of wireless internet connection. Once configuring the Wi-Fi module with an internet source, it acts as a client and sends the collected sensor data to the user device as a mobile application. The criteria of connecting all the sensors to the internet are Internet of Things (IoT). The concept of connecting the electronic devices, sensors, and automobile equipment together via internet.

RELATED WORK

So far, the weather monitoring systems mainly focused on the temperature, humidity and rainfall measurements [3]. There are systems, which measure the atmospheric pressure, temperature, humidity and display the results on an LCD screen [2]. In another system, they also measured temperature, humidity and barometric pressure and displayed the results in a GUI in a MATLAB platform and it seems to be more complex [4]. Here, we also concentrated on the monitoring of wind parameters such as wind velocity and wind direction and intensity of light. For this, we made use of raspberry pi3, which has 802.11 wirelesses LAN, and processing speed of this system is more than other previous systems. The data can be linked directly to the cloud via the internet, so that we can access the information of these weather parameters anywhere globally.

INTERNET OF THINGS (IoT)

IoT is the future technology that connects the things in the entire world at one place. All the objects, things and sensors can be connected together and share the data obtained at various locations and process/analyses that data for cooperation. Complete machine to machine interaction can be obtained by a wide range of connectivity of devices with various protocols and various properties that offered by IoT.

The other communication technologies like ZigBee, RF Link can't broadcast the information as they can only communicate peer to peer. IoT has a wide range of application areas, such as Medical applications for monitoring the health of a patient and sends the information wirelessly, and it makes the technologies like home automation, control systems, and wireless networks with sensors more efficient and smarter. IoT in automobile applications and traffic maintenance became a most using area of automation.

SYSTEM ARCHITECTURE

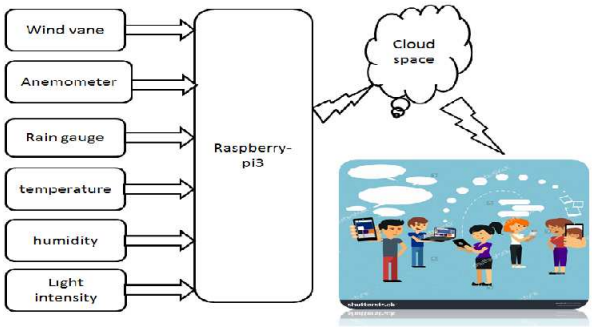


Figure:1 System Architecture

LITERATURE SURVEY

Much emphasis is not done in reducing the maintenance cost even though automated weather stations are built and implemented in remote parts of Sri Lanka. Automated weather stations have been developed in universities by interfacing microcomputer or commercially available data loggers with communication devices, ports and monitoring

sensors to obtain hard copies of weather data and meteorological parameter [4-6]. Recently, an automated weather station with USB communication facility and a built-in data logging facility has been developed by the University of Colombo.

The survey was firstly done on wireless technologies to establish a Wireless sensor network. The study went on choosing the suitable wireless technology. It should be suitable in all aspects like economic and technological. The primary concern, we have to make while choosing the communication method is range of communication. Here, we have chosen 802.11 b/g Wi-Fi. When we give an internet source, the data can be exchanged anywhere in the world through its IP address. The further study has been done by selecting the microcontroller. The system implementation is contained with a hidden goal of achieving low power consumable solution. The raspberry should also be low power consuming along with all the remaining sensors. We have chosen raspberry-pi3 which is low power raspberry with inbuilt Wi-Fi and works with only 3.3v. The next study went on the data logger methods on the web page. The data collected from the sensors are mostly in the form of integer values representing the value of environmental parameter. The web page displaying the data of sensors directly will not make a simpler impression for the users. It should be in a graphical representation for easy understanding of the users. The data hosted on an own web page will be more expensive and have to pay for it on a rental basis. To make the system less expensive, we preferred some free data hosting web sites which provide a cloud space for our sensor data to make it universal and also make the system less expensive.

FLOW CHART

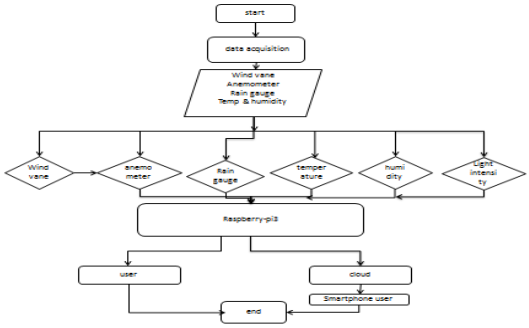


Figure 2: Flow Chart

WEATHER SENSORS

Weather sensors are intended to measure wind speed, direction, rainfall and temperature and humidity which are considered as one set. The rain gauge is bucket-type rain gauge, which becomes empty by itself and it activates a closing button momentarily for each 0.011" (0.2794mm) of rain collected. The anemometer (wind speed meter) closes a switch for each rotation and it encodes the wind speed by counting this number of switches closes. If the switch closes once per second, then it will be equal to wind speed of 1.492 MPH. Finally, the wind vane sensor consists of a set of resistors that reports wind direction as voltage. When we apply voltage, the voltage returned will indicate any one of the 16 possible positions depending on wind direction. A table shown in figure 3 gives more information about how this works, and voltages and resistance values for each position.

- **Raspberry-pi3**

Specifications

Processor: Chipset Broadcom BCM2387.

Quad-Core 1.2GHz ARM Cortex-A53 with Wi-Fi enabled.

Memory: 1GB low power double data rate synchronous DRAM (LPDDR2)

OS: Boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT.

Dimensions: 85 x 56 x 17mm

Power: Micro USB socket 5V1, 2.5A

Connectors

Ethernet	10 Base T Ethernet socket
Video Output	HDMI (rev 1.3 & 1.4Composite RCA (PAL and NTSC)
Audio Output	Audio Output 3.5mm jack, HDMI USB, 4 x USB 2.0 Connector
GPIO Connector	40-pin 2.54 mm (100 mil) Expansion header: 2x20strip. Providing 27 GPIO pins as well as +3.3 V, +5V and GND supply lines
Camera connector	15-pin MIPI Camera Serial Interface (CSI-2)
Display Connector	Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane.
Memory Card Slot	Push/pull Micro SDIO

Advantages

- Cheapest cost, Consistent board format, 10x faster processing, best compatibility

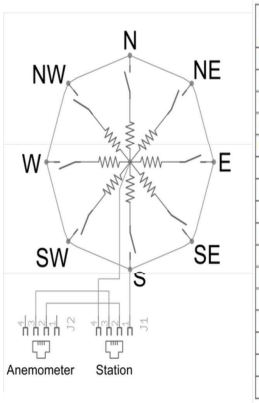
Applications

- Low cost PC/tablet/laptop, IoT application, Industrial/Home automation, Server/cloud server, Wireless access point, environmental sensing/monitoring (e.g. Weather Stations)

II Wind Direction

The wind direction is quite complex of the remaining sensors. With the base is removed here you can see 8 reed switches in a circle as shown in the figure 3. Which are connected to different resistors?

As the magnet attached to the wind direction on top revolves, it causes either one switch to close (if the magnet is directly above the switch) or two switches to close when the magnet is between the switches.



Direction (Degrees)	Resistance (Ohms)	Voltage (V=5v, R=10k)
0	33k	3.84v
22.5	6.57k	1.98v
45	8.2k	2.25v
67.5	891	0.41v
90	1k	0.45v
112.5	688	0.32v
135	2.2k	0.90v
157.5	1.41k	0.62v
180	3.9k	1.40v
202.5	3.14k	1.19v
225	16k	3.08v
247.5	14.12k	2.93v
270	120k	4.62v
292.5	42.12k	4.04v
315	64.9k	4.78v
337.5	21.88k	3.43v

Figure 3: Measurment of Wind Direction

The magnet may close two switches at once, allowing up to 16 different positions to be indicated. An external

resistor can be used to form a voltage divider, producing a voltage output that can be measured with an analog to digital converter, as shown figure [3]. The switch and resistor arrangement is shown in the diagram to the right. Resistance values for all 16 possible positions are given in the above table.

- **Wind Velocity**

The anemometer is a cup type and it measures the wind velocity by closing a contact as a magnet moves past a switch. This module uses a dry reed switch, which is not in physical contact with the atmosphere. Switch of the anemometer is connected to the inner two conductors of the RJ11 cable shared by the anemometer and wind vane (pins 2 and 3). A wind velocity of 1.492 MPH (2.4 km/h) causes the switch to close once per second.

- **Rain Gauge**

This rain gauge is a self-emptying tipping bucket type. The gauge switch is connected to the two center conductors of the attached RJ11-terminated cable. Each (0.011'') (0.2794 mm) of rain causes one momentary contact closure that can be recorded with a digital counter or microcontroller interrupt input.

- **Temperature & Humidity**

Temperature and humidity parameters can be measured by DHT11 sensor, which includes a high-performance a 8-bit microcontroller, humidity measurement resistive-type component, a negative temperature coefficient (NTC) - temperature measurement component, provides calibrated digital signal output, which leads to a high reliable and excellent long-term stability. Its compact size, less power consumption and capability of signal transmission up-to-20 meter, making it as the best choice for various applications

- **Light Intensity**

The digital light intensity sensor (BH1750FVI) uses the I2C interface and this allows it to connect with the Raspberry Pi with only four wires. This module allows the measurement of light as a digital number using a built –in 16-bit analogue-to-digital converter which makes the measurement process quick and cheap.

Table 1: Sensor to Raspberry pi Connection

Module PCB	Description	GPIO Header pins
GND	Ground	P1-14
ADD	Adder select	P1-14
SDA	I2C SDA	P1-03
SCL	I2C SCL	P1-05
VCC	3.3V	P1-01

HARDWARE CONNECTIONS WITH GPIOS ON RASPBERRY PI

Besides the VCC and GND, you just need to use one GPIO pin on the Raspberry Pi to make use of the DHT11 module.

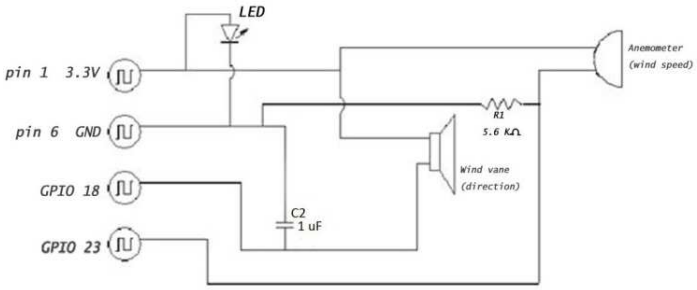


Figure 4: Hardware Connection with Raspberry-pi

RESULTS

Figure 5: Wind Direction

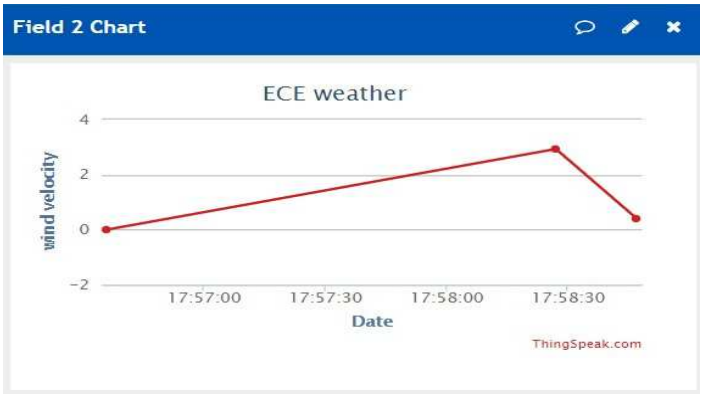


Figure 6:Wind Velocity

Figure 7:Rain Guage

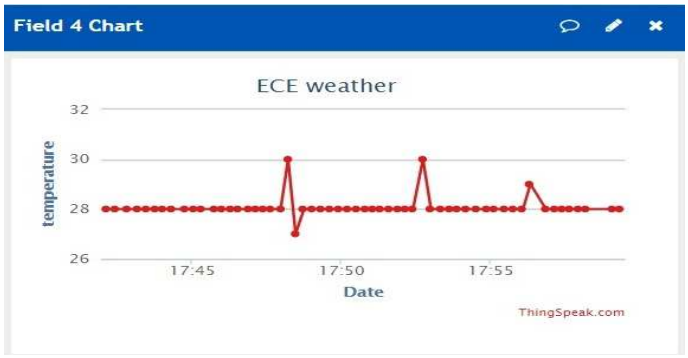


Figure 8:Tempareture

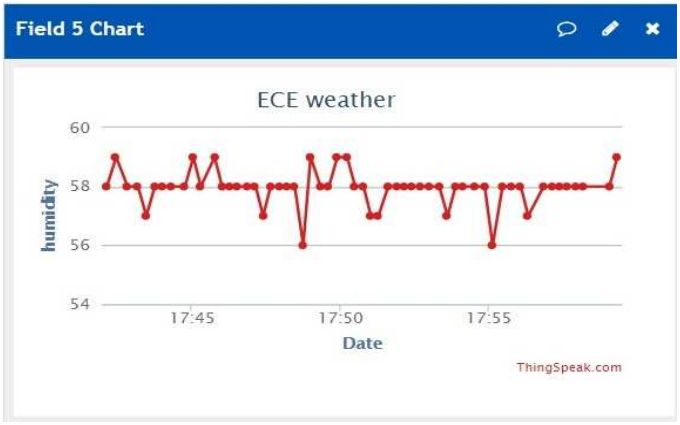


Figure 9: Humidity

FUTURE SCOPE

For many years, various research operations are being performed in the field of weather monitoring. One such good attempt is this i.e. to monitor the weather parameters in one location and to share the data globally through cloud. Thus, in the future, modifications can be made on this system to make it serve for other applications too.

We can add the new features like,

- Weather prediction is a very important factor, which forecasts the climate in a region based upon the values of weather parameters.
- This mini weather station can be made much more compact and reliable with the inclusion of miniature components and by increasing the scaling factor.
- As we made use of Raspberry pi3 in this model, immediate alert message or e-mail can be sent to the mobile phone, when the parameter changes are drastic.
- As the applications are limitless, other weather parameters can also be monitored easily with the addition of related sensors to the system architecture.

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